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ABSTRACT

This document summarizes sound ideas for teaching science, including developing thematic units of study; integrating subject matter; conducting embedded, ongoing assessments; using student input constructively; and grounding instruction in reliable learning theories. Four philosophies of education are mentioned to help in designing a science curriculum. Finally, two principles of learning are discussed and recommended for use when teaching science. (WRM)

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IMPROVING THE TEACHING OF SCIENCE

Science teachers need to stay abreast of recent trends in teaching science. They need to study, analyze, and appraise new developments in the teaching of science. I will indicate selected trends and discuss related comments. Each school might then appraise their very own science curriculum to make necessary changes. The science curriculum needs to be brought up to date frequently. Modification of the present science curriculum is necessary so that pupils achieve as much as possible in each unit of study (Ediger, 1996).

Recommended Trends in Teaching Science

First, the science teacher needs to develop thematic units of study which provide for individual differences. In the science unit, there needs to be a carefully thought through set of objectives. These objectives should emphasize vital subject matter, skills, and attitudinal objectives. Subject matter for the objectives section should be based upon structural ideas identified by university professors in science, public school teachers, and school administrators. Structural ides represent key concepts an generalizations in each unit of study. These concepts and generalizations represent important and relevant content in science. The skills objectives section should stress, among others, critical thought whereby pupils separate the accurate from the inaccurate, the relevant from the irrelevant as well as the important from the unimportant ideas in science content.

Generally with critical thinking, the content chosen will fit into the solving of problems in science. Pupils with teacher guidance need to identify problems in ongoing units of study in science. Each problem is adequately delimited and salient. Information is then needed to secure content as an answer to the problem(s) identified. Creative thinking, as a further skill, is necessary so that pupils come up with unique, novel solutions to problem areas. Tried and true solutions may not work. Therefore originality in pupil skills is needed so that problems are identified and solved. After adequate data has been secured, the pupil needs to test the solution in a lifelike situation. Should the solution work, the hypothesis (tentative answer to the problem) is accepted. If the answer to the problem does not work, a new solution needs to be found with further collecting of information.

In addition to subject matter and skills objectives, a third kind of objective for the science teacher to stress is attitudinal objectives.

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Attitudinal objectives include developing pupil interest in science, establishing diverse purposes for learning, wanting to learn more science, and wishing to use science content in every day life.

A second trend in teaching science emphasizes relating subject matter acquired in ongoing lessons and units of study. If pupils learn to correlate and integrate subject matter, the chances are less forgetting will occur. Why? a pupils who thinks of content being related will find that one idea recalled triggers other ideas to the level of consciousness. The process is continuous in that each idea recalled will assist in the recollection of others. Thus, the areas of biology, chemistry, geology, astronomy, physics, and geology may be taught as being interrelated.

Third, inservice education is necessary so that teachers keep abreast of modern methods of instruction. The workshop and faculty meeting approaches need to stress what teachers deem to be of help in the instructional arena. Teachers need to have much input into the development of inservice education programs. Ideas gleaned from inservice education need to be applied in teaching and learning situations. Feedback to participants need to be given at the inservice education meeting so that others may try new ideas in teaching to assist each pupil to achieve as optimally as possible.

Fourth, teachers need to appraise pupils more so within the actual engagement of learning, rather than external factors. What are these external situations? Testing in their diverse dimensions tend to be outside the actual specific act of learning. Rather, evaluating a pupil within the framework of being involved in performing science experiments in ongoing lessons and units of study stresses the constructivist philosophy. With constructivism as a philosophy of evaluation, the pupil is evaluated within the framework of teaching and learning, not outside of it. Thus, within science experiments, demonstrations, viewing audio-visual materials, reading science content, giving a book report, making a diagram, constructing a graph, and doing an art project related to the thematic unit being studied, pupils reveal achievement and progress. Evaluation may then be continuous. Diagnosis and remediation are possible in constructivism as a philosophy of evaluation.

Fifth, pupils need to indicate progress to teachers, parents, and school administrators through the development of the portfolio. A portfolio contains a collection of relevant materials of pupil achievement in ongoing units of study. A representative sampling of pupil work needs to be a part of the portfolio. To organize the portfolio properly, the pupil with teacher guidance needs to select those products and processes that reveal learner progress. A table of contents is needed as well as a selection of listed worthwhile objectives to achieve. The objectives need to guide pupil achievement in selecting what goes into a portfolio. Items for a portfolio might include written work, art products, construction endeavors, snapshots of pupil work, videotapes of

collaborative endeavors, and drawings, as well as statistical data in the form of graphs and tables. The completed portfolio may be shown to parents and others who are responsibly involved in evaluating pupil achievement. The philosophy of constructivism is involved in that pupil work reflects what was done within different ongoing lessons and units of study. What about test results? By all means, these should be a part of the portfolio contents. However, they are a part of the portfolio and should not dominate the contents therein. The portfolio should not become unwieldy, but represents what a pupil has completed in terms of being a representative sampling.

Sixth, there should be ample input into thematic science units of study from the pupil. The pupil needs to be actively engaged in learning and therefore needs to have input in terms of objectives, learning activities, and evaluation procedures to be stressed in the science unit of study. For this kind of pupil input, I would suggest a set of learning centers as being the heart of the thematic unit of study in science.

With learning centers as the heart of the thematic science unit of study, pupils individually may choose which center and which tasks to pursue sequentially. The tasks need to have learner appeal and inherent interest. The learner might then order his/her own tasks to pursue as learning opportunities. Ideally, there should be more tasks than what a pupil can complete so that omissions can be made. Time on task is very important for each pupil so learners achieve as much as possible. A psychological sequence is involved when pupils individually choose the order of their very own tasks to complete.

The learning centers may also be used for enrichment activities. Here, a more limited number of learning centers are available for pupils to choose from, but these tasks are used to supplement pupils' work from other kinds of learning activities not found at the learning centers. When spare time is available, a pupil may work at the enrichment centers to achieve additional objectives in the thematic science unit of study. The teacher then selects most of the objectives, learning opportunities, and evaluation procedures in the regular science curriculum with a logical sequence being in evidence. Why is this a logical sequence? The science teacher orders which activities come first, second, third, and so on in teaching and learning. These activities are selected on the basis of being meaningful and purposeful to involved learners.

Seventh, the psychology of pupil learning needs to be selected based on how pupils individually and collaboratively may achieve as much as possible. Behaviorism stresses stating objectives in science in measurable terms prior to instruction. The teacher develops and orders the objectives for pupils to attain. Learning activities are chosen by the teacher on the basis of having pupils achieve the objectives. With precise objectives of instruction, a pupil either does or does not achieve the stated objectives as a result of instruction. If a pupil fails to attain an objective, he/she may experience a different teaching strategy.

Criterion referenced tests (CRTS) are a major way to determine pupil achievement. These tests are aligned with the stated objectives so that validity and reliability in testing is in evidence.

In addition to behaviorism as a psychology of learning being emphasized in teaching, a somewhat opposite approach stresses pupil/teacher planning of objectives, learning opportunities, and evaluation procedures. Here, the pupil may have opportunities to plan with the teacher the objectives of instruction as well as the learning opportunities to achieve the objectives. Evaluation procedures to ascertain what has been learned might also be planned cooperatively with the science teacher. Planning together involving the pupil with teacher assistance is a difficult method of instruction. However, the end result is that pupils have a better chance of experiencing unit teaching that meets personal needs and interests.

In between points of view may be stressed in ongoing units of study such as having some teacher determined facets of the science curriculum, such as in behaviorism, as well as emphasizing pupil input into the curriculum such as in the pupil/teacher planning model of unit teaching in science. What determines which plan to implement in teaching pupils?

1. under which conditions does the pupil do best in learning?
2. under which plan are pupil's needs and interests met best ?
3. under which plan of instruction does the teacher do the best job of professional teaching?
4. under which plan might the psychological needs of pupils and teachers be met best?
5. under which conditions can the methods of science be taught so that pupils experience excitement and optimal achievement in a positive learning environment? (Ediger, 1994).

Eighth, the philosophy of education needs to be considered in designing the science curriculum. There are diverse philosophies which assist pupils to achieve more optimally. A problem solving philosophy certainly does harmonize well with objectives to be stressed in science. Science educators seemingly agree that problem solving should be at or near the apex of objectives for pupils to achieve in ongoing lessons and units of thematic study. To be involved in problem solving, pupils also need to think critically when data is gathered in answer to the problem. Creative thought is needed when unique solutions are necessary for answers to problem solving.

A second philosophy stresses an idea centered science curriculum. Here, the teacher guides pupils to achieve objectives in science which stress the abstract in concept development and achievement of generalizations. The abstract is prized more highly in teaching science as compared to the concrete and semi-concrete learning activities. However, the concrete and semi -concrete are valued as learning experiences that assist pupils to achieve abstractions in science lessons

and units of study.

A third philosophy stresses pupils attaining measurable results in the science curriculum. Thus, a pupil can pinpoint an exact level of achievement in science such as the fiftieth percentile or being one standard deviation above the mean. With quality tests that are valid and reliable, the teacher may pinpoint the exact achievement level of the involved learner. Here, the precise objectives are stated prior to instruction. The learning opportunities guide pupils to achieve each measurably stated objective in ongoing science lessons and units of study. Test results indicate how well a pupil is doing in science.

A fourth philosophy of education in teaching science emphasizes a decision making model. Here, the learner is actively involved in planning the objectives, learning activities, and evaluation procedures in teaching and learning. The pupil with teacher assistance is to be a responsible person in selecting what to learn in the science curriculum. What is learned in science units may stress problem solving, an idea centered approach. and/or achieving measurably stated objectives. The decision making model emphasizes pupils being accountable for goal attainment in the science curriculum. In deciding upon which philosophy of science teaching to stress, the teacher will need to appraise his/her strengths in the instructional arena as well as appraise learner progress involving to teaching and learning in the science curriculum. The choice(s) zero in upon pupils needing to attain as optimally as possible in science instruction (Ediger, 1997, pp.1-7)

Principles of Learning

There are specific principles of learning that are recommended to be used in teaching pupils on science. These principles of learning are advocated by educational psychologists in the teaching arena:

1. set establishment is important. If pupils are to learn and achieve, their attention must be secured in ongoing learning experiences. A definite strategy needs to be formulated by the science teacher to obtain pupil attention for teaching and learning situations. Pupils who do not attend to the ongoing lesson do not attain as much as they should.

2. pupils need to possess reasons for achieving stated objectives in science. The science teacher may use an inductive approach in guiding pupils to establish reasons for learning. Here, the teacher asks questions of learners in class on why it is salient to master what is contained in the stated objectives. Or a deductive procedure may be emphasized in that the teacher might explain to pupils why it is important to learn that which is contained in the listed objectives on the chalkboard or overheard projector. Teachers advocating extrinsic rewards may announce prizes/awards for pupils who attain a certain precise level of achievement in science. Pupils need to be clear on what to learn so

that the prize/award is obtained.

3. pupils need to perceive relationships of the new subject matter to be taught with the previous content emphasized and mastered. Quality sequence is an end result.

4. time on task is relevant. Here, pupils perceive as worthwhile that which is being presented as learning opportunities to achieve objectives.

5. motivation for learning is in evidence in that each pupil is revealing a higher energy level for accomplishment in sequential units of study in science.

6. learners attach meaning to content presented. Understanding and comprehension of ideas gleaned make for meaningful learning.

Conclusion

The science teacher needs to use diverse ingredients in teaching and learning which guide learner optimal progress. The structure of knowledge, the psychology of learning, the philosophy of education, and vital principles of learning need to be used to determine and organize a purposeful set of sequential units in science instruction. Subject matter, skills, and attitudinal objectives must reflect careful planning by the science teacher. Learning opportunities should guide pupils to achieve objectives. Evaluation of achievement needs to indicate the kinds of progress made by pupils in ongoing lessons and units of study. Diverse evaluation procedures need to be used to acquire information pertaining to each pupil's progress in science. The information obtained should be used to plan further sequential units of instruction (Ediger, 1995).

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